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Comprehensive Report to Congress Clean Coal Technology Program

Air-Blown Integrated Gasification Combined Cycle Demonstration Project

**A Project Proposed By:
CRSS Capital, Inc. and
TECO Power Service Corporation**

U.S. Department of Energy
Assistant Secretary for Fossil Energy
Office of Clean Coal Technology
Washington, D.C. 20585

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1.0 EXECUTIVE SUMMARY

In September 1988, Congress provided $575 million to conduct cost-shared Clean Coal Technology (CCT) projects to demonstrate technologies that are capable of retrofitting or repowering existing facilities. To that end, a Program Opportunity Notice (PON) was issued by the Department of Energy (DOE) in May 1989, soliciting proposals to demonstrate innovative energy efficient technologies that were capable of being commercialized in the 1990's, and were capable of (1) achieving significant reductions in the emissions of sulfur dioxide and/or the oxides of nitrogen from existing facilities to minimize environmental impacts such as transboundary and interstate pollution, and/or (2) providing for future energy needs in an environmentally acceptable manner.

In response to the PON, 48 proposals were received in August 1989. After evaluation, 13 proposals were selected for negotiations in December 1989 as best furthering the goals and objectives of the PON. The projects proposed in the proposals were located in 10 different states and represented a variety of technologies. A proposal from CRSS Capital, Inc., and TECO Power Services Corporation (TECO) was one of those selected for negotiation. Following selection, CRSS Capital and TECO formed a partnership entity, Clean Power Cogeneration, Inc. (CPC), hereafter known as the Industrial Participant.

CPC has requested financial assistance from DOE for the design construction, and operation of a nominal 1,270 ton-per-day (120-MWe), air-blown integrated gasification combined-cycle (IGCC) demonstration plant. The project site is at the City of Tallahassee's Arvah B. Hopkins power station located approximately 10 miles west of Tallahassee, Florida, as shown in Figure 1. The demonstration plant, entitled Air-Blown Integrated Gasifier Combined Cycle, would produce both power for the utility grid and steam for a nearby industrial user. The project, including the demonstration phase will last 60 months at a total cost of $242 million. DOE's share of the project cost would be 50.0 percent, or $121 million.

The objective of the proposed project is to demonstrate air-blown, fixed-bed Integrated Gasification Combined Cycle (IGCC) technology. The integrated performance to be demonstrated will involve all the subsystems in the air-blown IGCC system to include coal feeding; a pressurized air-blown, fixed-bed gasifier capable of utilizing caking coal; a hot gas conditioning system for removing sulfur compounds, particulates, and other contaminants as necessary to meet environmental and combustion turbine fuel requirements; a conventional combustion turbine appropriately modified to utilize low-Btu coal gas as fuel; a briquetting system for improved coal feed performance; the heat recovery steam generation system appropriately modified to accept a NO_x reduction system such as the selective catalytic reduction process; the steam cycle; the IGCC control systems; and the balance of plant. The base feed stock for the project is an Illinois Basin bituminous high-sulfur coal, which is a moderately caking coal.

It is anticipated that, if the demonstration is successful, the air-blown, fixed-bed IGCC technology will be commercialized during the 1990's and will be a highly efficient system capable of achieving significant reduction in the

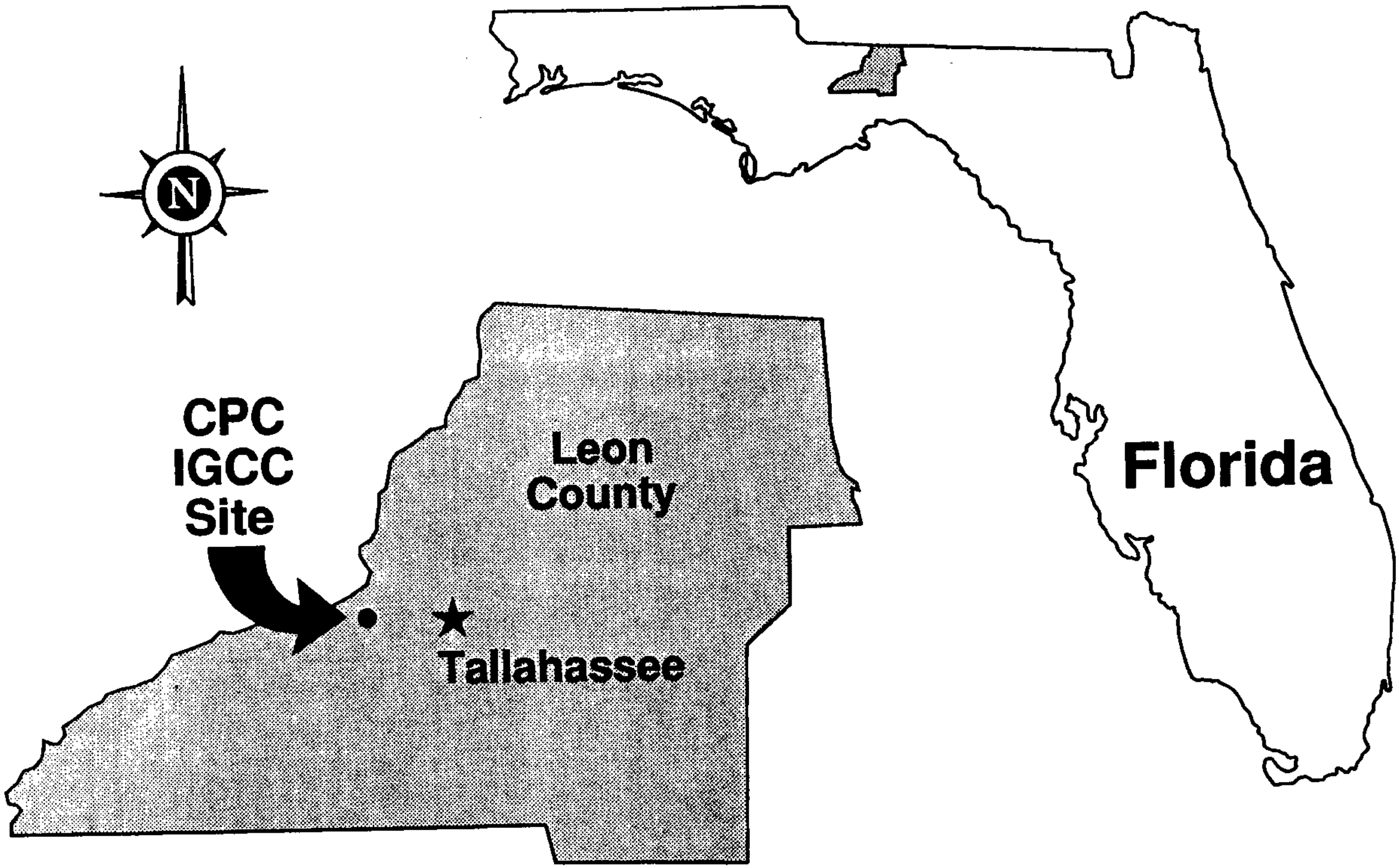

Figure 1. Location of CPC Air-Blown IGCC Demonstration Project

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emissions of sulfur dioxide and the oxides of nitrogen when compared with available conventional technology options.

CPC, as the General partner in Clean Power Cogeneration Limited Partnership, will be the signatory to the Cooperative Agreement. CPC will own and operate the demonstration plant and be responsible for all licensing and commercialization of the IGCC technology.

2.0 INTRODUCTION AND BACKGROUND

The domestic coal resources of the United States play an important role in meeting current and future energy needs. During the past 20 years considerable effort has been directed to developing improved coal combustion, conversion, and utilization processes to provide efficient and economic energy options. These technology developments permit the efficient use of coal in a cost-effective and environmentally acceptable manner.

2.1 REQUIREMENT FOR A REPORT TO CONGRESS

On September 27, 1988, Congress made available funds for the third clean coal demonstration program (CCT-III) in Public Law 100-446, "An Act Making Appropriations for the Department of the Interior and Related Agencies for the Fiscal Year Ending September 30, 1989, and for Other Purposes" (the "Act"). Among other things, this Act appropriates funds for the design, construction, and operation of cost-shared, clean coal projects to demonstrate the feasibility of future commercial applications of such "... technologies capable of retrofitting or repowering existing facilities ..." On June 30, 1989, Public Law 101-45 was signed into law, requiring that CCT-III projects be selected no later than January 1, 1990.

Public Law 100-446 appropriated a total of $575 million for executing CCT-III. Of this total, $6.906 million are required to be reprogrammed for the Small Business and Innovative Research Program (SBIR) and $22.548 million are designated for Program Direction Funds for costs incurred by DOE in implementing the CCT-III program. The remaining, $545.546 million, was available for award under the PON.

The purpose of this Comprehensive Report is to comply with Public Law 100-446, which directs the Department to prepare a full and comprehensive report to Congress on each project selected for award under the CCT-III Program.

2.2 EVALUATION AND SELECTION PROCESS

DOE issued a draft PON for public comment on March 15, 1989, receiving a total of 26 responses from the public. The final PON was issued on May 1, 1989, and took into consideration the public comments on the draft PON. Notification of its availability was published by DOE in the Federal Register and the Commerce Business Daily on March 8, 1989. DOE received 48 proposals in response to the CCT-III solicitation by the deadline, August 29, 1989.

2.2.1 PON Objective

As stated in PON Section 1.2, the objective of the CCT-III solicitation was to obtain "proposals to conduct cost-shared Clean Coal Technology projects to demonstrate innovative, energy-efficient technologies that are capable of being commercialized in the 1990's. These technologies must be capable of (1) achieving significant reductions in the emissions of sulfur dioxide and/or the oxides of nitrogen from existing facilities to minimize environmental impacts such as transboundary and interstate pollution and/or (2) providing for future energy needs in an environmentally acceptable manner."

2.2.2 Qualification Review

The PON established seven Qualification Criteria and provided that, "In order to be considered in the Preliminary Evaluation phase, a proposal must successfully pass Qualification." The Qualification Criteria were as follows:

(a) The proposed demonstration project or facility must be located in the United States.

(b) The proposed demonstration project must be designed for and operated with coal(s) from mines located in the United States.

(c) The proposer must agree to provide a cost share of at least 50 percent of total allowable project cost, with at least 50 percent in each of the three project phases.

(d) The proposer must have access to, and use of, the proposed site and any proposed alternate site(s) for the duration of the project.

(e) The proposed project team must be identified and firmly committed to fulfilling its proposed role in the project.

(f) The proposer agrees that, if selected, it will submit a "Repayment Plan" consistent with PON Section 7.4.

(g) The proposal must be signed by a responsible official of the proposing organization authorized to contractually bind the organization to the performance of the Cooperative Agreement in its entirety.

2.2.3 Preliminary Evaluation

The PON provided that a Preliminary Evaluation would be performed on all proposals that successfully passed the Qualification Review. In order to be considered in the Comprehensive Evaluation phase, a proposal must be consistent with the stated objective of the PON, and must contain sufficient business and management, technical, cost, and other information to permit the Comprehensive Evaluation described in the solicitation to be performed.

2.2.4 Comprehensive Evaluation

The Technical Evaluation Criteria were divided into two major categories: (1) Demonstration Project Factors used to assess the technical feasibility and likelihood of success of the project, and (2) Commercialization Factors used to assess the potential of the proposed technology to reduce emissions from existing facilities as well as to meet future energy needs through the environmentally acceptable use of coal, and the cost effectiveness of the proposed technology in comparison to existing technologies.

The Business and Management Criteria required a funding plan and an indication of financial commitment. These were used to determine the business performance potential and commitment of the proposer.

The PON provided that the cost estimate would be evaluated to determine the reasonableness of the proposed cost. Proposers were advised that this determination "will be of minimal importance to the selection," and that a detailed cost estimate would be requested after selection. Proposers were cautioned that if the total project cost estimated after selection is greater than the amount specified in the proposal, DOE would be under no obligation to provide more funding than had been requested in the proposer's cost-sharing plan.

2.2.5 Program Policy Factors

The PON advised proposers that the following program policy factors could be used by the Source Selection Official to select a range of projects that would best serve program objectives:

(a) The desirability of selecting projects that collectively represent a diversity of methods, technical approaches, and applications.

(b) The desirability of selecting projects in this solicitation that contribute to near-term reductions in transboundary transport of pollutants by producing an aggregate net reduction in emissions of sulfur dioxide and/or the oxides of nitrogen.

(c) The desirability of selecting projects that collectively utilize a broad range of U.S. coals and are in locations which represent a diversity of EHSS, regulatory, and climatic conditions.

(d) The desirability of selecting projects in this solicitation that achieve a balance between (1) reducing emissions and transboundary pollution, and (2) providing for future energy needs by the environmentally acceptable use of coal or coal-based fuels.

The word "collectively" as used in the foregoing program policy factors, was defined to include projects selected in this solicitation and prior Clean Coal solicitations as well as other ongoing demonstrations in the United States.

2.2.6 Other Considerations

The PON provided that in making selections, DOE would consider giving preference to projects located in states for which the rate-making bodies of those states treat the Clean Coal Technologies the same as pollution control projects or technologies. This consideration could be used as a tie breaker if, after application of the evaluation criteria and the program policy factors, two projects receive identical evaluation scores and remain essentially equal in value. This consideration would not be applied if, in doing so, the regional geographic distribution of the projects selected would be altered significantly.

2.2.7 National Environmental Policy Act (NEPA) Compliance

As part of the evaluation and selection process, the Clean Coal Technology Program developed a procedure for compliance with the National Environmental Policy Act of 1969, the Council on Environmental Quality (CEQ) for implementing NEPA (40 CFR Parts 1500-1508) and the DOE guidelines for compliance with NEPA (52 F.R. 47662, December 15, 1987).

This procedure included the publication and consideration of a publicly available Final Programmatic Environmental Impact Statement (DOE/EIS-0146) issued in November 1989, and the preparation of confidential preselection project-specific environmental reviews for internal DOE use. DOE also prepares publicly available site-specific documents for each selected demonstration project as appropriate under NEPA.

2.2.8 Selection

After considering the evaluation criteria, the program policy factors, and the NEPA strategy as stated in the PON, the Source Selection Official selected 13 proposals as best furthering the objectives of the CCT-III PON. On December 21, 1989, the Secretary of Energy, Admiral James D. Watkins, U.S. Navy (Retired), announced the selection of the 13 proposals.

3.0 TECHNICAL FEATURES

3.1 PROJECT DESCRIPTION

The CPC Project provides for the construction and operation of a 120-MWe air-blown integrated gasifier combined-cycle (IGCC) demonstration plant. The plant, located at the Hopkins power plant near Tallahassee, Florida, will demonstrate the integrated performance of an air-blown, fixed-bed coal gasifier island coupled to a combustion and steam turbine power island. The key subsystems of the gasifier island include a coal feeder and a briquetting system (for improved coal feed performance); two pressurized air-blown, fixed-bed coal gasifiers (Lurgi) capable of utilizing caking coals; a hot gas conditioning system for removing sulfur compounds, particulates, and other contaminants as necessary to meet environmental and combustion turbine fuel requirements. The key subsystems of the power island include; a GE combustion turbine (nominal 90-MWe) capable of operating with a low-Btu coal gas fuel; a heat-recovery steam generation (HRSG) system appropriately modified to accept a NO_x reduction system such as a Selective Catalytic Reduction (SRC) process; a GE steam turbine (nominal 30-MWe); all control systems; and the balance of plant. Emissions of SO_2 and NO_x will be below the limits set by current regulations.

The project activities include engineering and design, permitting, procurement, construction, start-up, and demonstration. During the 24-month demonstration phase, the IGCC plant will be operated on several high-sulfur coals. The project represent a critical step in the commercialization of fixed-bed gasification IGCC system by demonstrating that commercially available components can be integrated into a power plant with high system efficiency, attractive system operating characteristics and competitive capital and operating economics.

Successful demonstration of this project will encourage industrial power producers such as CPC and utilities to construct similar size or larger units (by adding gasifier island modules) and eventual wide-scale deployment of the fixed-bed IGCC technology.

3.1.1 Project Summary

Title:	Clean Power Cogeneration Air-Blown IGCC Demonstration Project
Proposer:	CRS Capital, Inc.
Location:	Arvah B. Hopkins Power Plant, Tallahassee, Florida
Technology:	Air-Blown, Fixed-Bed Gasification Combined Cycle
Application:	Utility power generation, independent power production, industrial cogeneration (PURPA qualifying)
Type of Coal Used:	High-Sulfur Eastern Bituminous
Products:	Power and Steam
Project Size:	120-MWe, 1,270 tons of coal per day
Project Start Date:	March 1991
Project End Date:	March 1996

3.1.2 Project Sponsorship and Cost

Project Sponsor:	Clean Power Cogeneration, Inc.
Co-Funders:	U.S. Department of Energy
Estimated Project Cost:	$241,458,000
Cost Distribution:	Participant Share, 50.0 percent DOE Share, 50.0 percent

3.2 IGCC PROCESS

3.2.1 Overview of Process Development

The CPC IGCC is similar to, but improves upon, first-generation IGCC technology in several aspects. The Participant believes its Lurgi-based, air-blown gasification technology will provide a higher thermal efficiency than an oxygen-blown system because it consumes less auxiliary power. Additional efficiencies are gained through an advanced hot gas cleanup system, which avoids the thermal penalties associated with cooling the gas for cleaning and then reheating it for delivery to the turbine. The inherent modular design of the system is expected to yield lower engineering and construction costs.

Lurgi has extensive experience in coal gasification through its role in the production of synthesis gas for the SASOL coal liquefaction plants in South Africa. The Lurgi Dry Ash Coal Gasification Process was developed in the early 1930's in the Hirschfelde pilot plant in Germany. The first commercial plant was built in 1936. Lurgi gasifiers have been operated in an oxygen-blown mode at SASOL and Great Plains Plant and in an air-blown mode at the German Lunen power station. Lurgi experience at SASOL includes successful operation with a moderate caking Kentucky No. 9 coal.

There have been many such fixed-bed processes developed, sold, and commercially operated. These include the Wellman-Galusha, the Stoic, and others. The Bureau of Mines (now METC) in the mid-1960's modified a Wellman-Galusha gasifier to operate in a pressurized mode. The offgas was subjected to a hot gas particulate cleanup via commercial cyclones. Extensive use of this unit by METC has provided the basis for utilization of downstream cleanup systems for the second-generation gasification combined-cycle power plants.

General Electric in the 1970's determined that the fixed-bed gasifier was an excellent application for gas turbines based primarily on the fact that the usable energy was predominantly chemical, rather than sensible. GE constructed their own gasifier and have extensively operated it with both corporate and DOE funding. The unit was converted to evaluate hot gas cleanup systems for both particulate and sulfur removal. These evaluations confirm the potential for hot gas cleanup as an integral part of an IGCC system.

3.2.2 Process Description

The two major components of the Air-Blown IGCC demonstration plant are the gasification island and the power island. Figure 2 is a basic process flow schematic for the plant. The plant gasifies approximately 1,270 tons/day of coal at full load. Coal is pulverized and sized using conventional technology. Fines from the pulverizer and the primary cyclone downstream of the gasifier are briquetted. The sized and briquetted coal streams are then pressurized and metered via lockhoppers and subsequently injected into the gasifier.

Air is compressed in a GE Frame 7E-A gas turbine unit to approximately 11.7 atmospheres. After exiting the compressor the flow is split into two streams. The first stream (primary) continues to the combustor as in a traditional unit while a side stream is diverted to a gasifier "island."

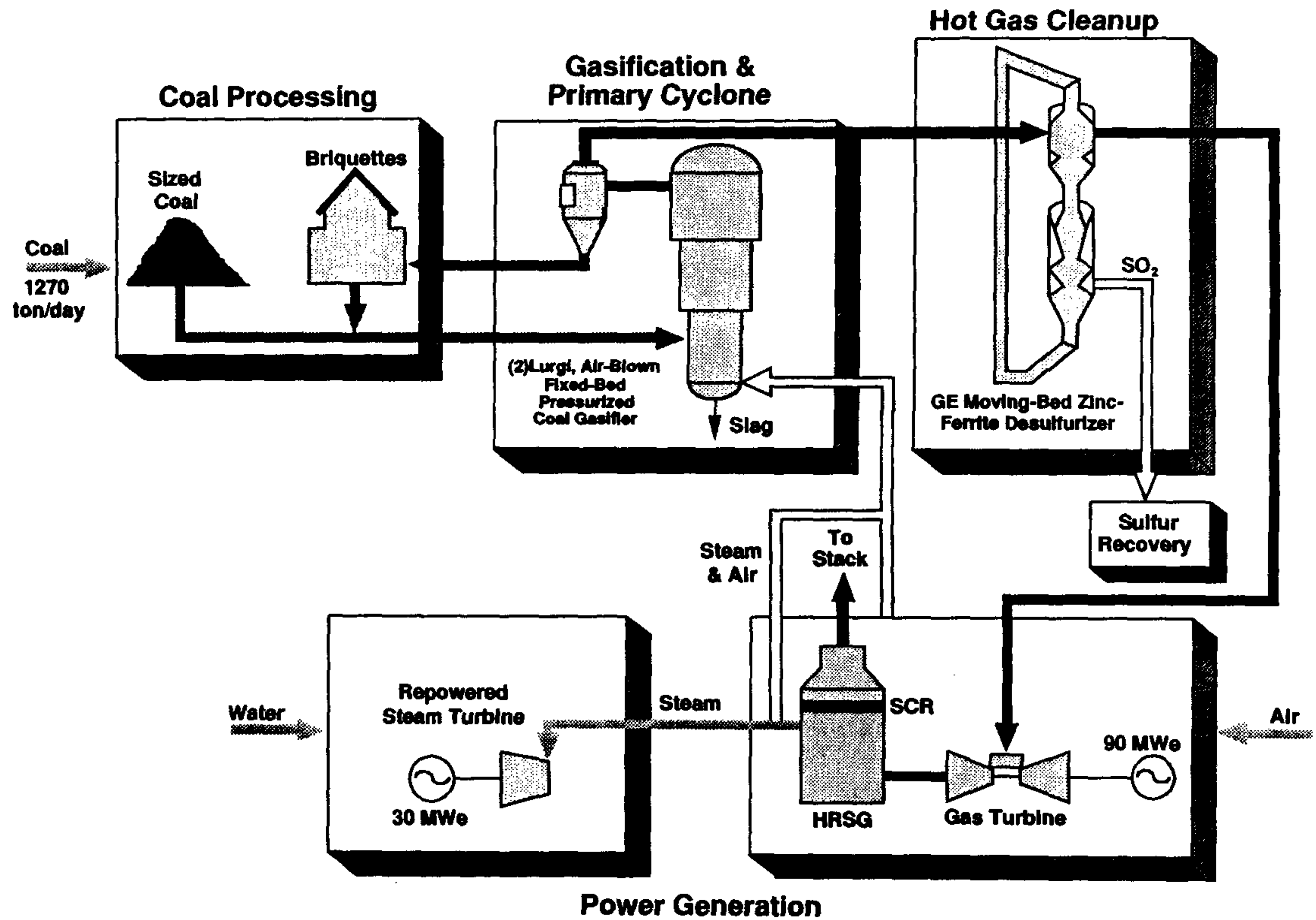

Figure 2. Clean Power Cogeneration Air-Blown IGCC Project Schematic

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The air to the gasifier island is boosted to around 268 psia and injected into the Lurgi gasifier counter to the direction of the coal flow. Within the gasifier the compressor air together with steam provided from the combined cycle is mixed with cooling jacket steam that is generated by the gasifier. The resulting reaction produces a low-Btu gas, on the order of 120 to 160 Btu's per standard cubic feet. The exhaust temperature from the gasifier is maintained at a level above the condensation temperature of the tars and hydrocarbon vapors that are contained within the gasifier stream to prevent line fouling problems.

The gasifier exhaust also contains coal "fines" which consist primarily of carbon entrained in the gasifier exhaust flow. These fines are removed in a high-efficiency cyclone, briquetted and reinjected with the coal feed stream. After removal of the fines, the gasifier effluent is directed to the hot gas cleanup unit.

The combined steam and low-Btu gas mixture which enters the hot gas cleanup unit is stripped of hydrogen sulfide through interaction with a counterflowing metal oxide absorption system. This hot gas cleanup unit provides sulfur removal in a thermally compatible, high-temperature way, but it also removes some of the alkali metals that were liberated in the gasifier. It further serves as a mechanical particulate filter backup to the gasifier cyclone.

Subsequent to the low-Btu gas exiting the hot gas cleanup unit, it is mixed with the primary air from the compressor in the GE MS7000 combustion cans. Hot gases from the combustor, at approximately 1,900° to 2,000°F, pass through the expansion turbine which is slaved to both the compressor of the GE MS7000 machine and to a nominal 90-MWe generator mounted on the gas turbine skid.

The exhaust flow from the gas turbine, at a temperature of approximately 950° to 1,000°F, is admitted to a conventional HRSG. In the HRSG, a commercial SCR unit is included to control NO_x associated with the fuel based ammonia produced by the fixed-bed gasifier. In passing through the HRSG, the gas stream temperature is reduced to 250° to 300°F. With the concurrent reduction of the temperature of the gas stream, steam is produced at 1,250 psia and 950°F. The steam from the HRSG is then directed to the steam turbine portion of the combined cycle where it expands through a steam turbine coupled to a nominal 30-MWe electrical generator.

Steam turbine effluent is then directed to the steam condenser and subsequently redirected through the steam loop of the combined cycle. The condenser is cooled by a waterloop connected to a cooling tower which utilizes forced draft circulation.

3.3 GENERAL FEATURES OF PROJECT

3.3.1 Evaluation of Developmental Risk

Subsequent to selection and as a part of the fact-finding process, DOE performed a detailed evaluation of the CPC Air-Blown IGCC Project and determined it to be reasonable and appropriate. The evaluation focused on the project's technical, schedule, and cost risks. A team of experts from within DOE and available under contract contributed to the evaluation. The data base for the evaluation included Industrial Participant furnished documentation and DOE fact-finding discussions between DOE and its Participant.

The scope of the project includes design, construction, start-up, and operation of the facility. The design of the demonstration plant will utilize information available from several ongoing pilot plant tests at GE (zinc ferrite, and low-Btu, gas-fired combustor development). The technical feasibility is discussed in more detail in Section 3.3.1.2.

All major subsystems, with the exception of the hot gas cleanup section, have been commercially used in similar applications. However, they have not been previously combined in a single system. Since most elements of the IGCC have been demonstrated at commercial scale and the major plant equipment is essentially of an off-the-shelf type, this process is for the most part comprised of proven features.

The 60-month schedule allows sufficient time for the detailed design, construction, start-up and operation of the demonstration plant. The schedule is shown in Section 6.2. Based on information presented in the proposal and additional information submitted by the project team during fact-finding, the schedule, which is dependent on a aggressive NEPA review and permitting process, was judged to be "tight" but reasonable.

The cost estimate, evaluated during the fact-finding process, was prepared using conceptual engineering, equipment lists, site plans, significant vendor bids, and in-house historical labor and material costs. Where quotations were not available, costs were estimated by using the extensive CRS Sirrine data base for similar, commercially available equipment and applying appropriate scaling factors.

3.3.1.1 Similarity of Project to Other Demonstration and Commercial Efforts

The CPC Air-Blown IGCC Project merges the proven experience of conventional gas-fired combined cycle, Lurgi fixed-bed gasifier technology with an advanced GE hot gas cleanup system. Similarities exist between the Cool Water oxygen-blown IGCC project, Clean Coal Technology's (CCT)-I KRW and Foster Wheeler IGCC projects utilizing combined cycle systems coupled to fluidized bed gasifiers, and the CCT-II Combustion Engineering entrained-flow gasification repowering project.

3.3.1.2 Technical Feasibility

As discussed in Section 3.3.1, DOE recognizes that technical uncertainties exist in the proposed project, primarily in the hot gas cleanup system performance and scale-up and in overall IGCC plant integration. Many of these uncertainties are inherent with any new IGCC technology until it becomes fully commercial. CPC is confident that all technical uncertainties will be resolved during the 32 months scheduled for checkout, start-up and demonstration of the IGCC system. The project will be particularly helped by the information gained from the current GE zinc ferrite pilot plant and low-Btu combustion tests.

3.3.1.3 Resource Availability

All of the resources required for the project are available. The Participant has site access to the property owned by the City of Tallahassee, Arvah B. Hopkins power plant. CPC has also met the requirement for its share of the project financing through the first two budget periods. Essential infrastructure services are available including water, natural gas, rail and highway access, electric service, and sanitary waste disposal.

3.3.2 Relationship Between Project Size and Projected Scale of Commercial Facility

The U.S. electric utility industry currently expects a market to develop beginning in the next 10 years, for 100- to 300-MWe generation units as add-on capacity and for repowering or retrofitting aging power plants. The CPC demonstration plant, designed for 120-MWe is an ideal size for large applications. Multiple units of this plant can be installed simply and cheaply. The size of the demonstration plant has been chosen not only to prove the air-blown, fixed-bed IGCC technology, but to provide a sufficient volume of product for full-scale commercial testing. The Participant believes that scale-up from the demonstration scale to a commercial scale should be a smooth transition.

3.3.3 Role of Project in Achieving Commercial Feasibility of Technology

The project is expected to begin operation in 1994. Verification of the commercial feasibility of the technology will be accomplished through the 24-month demonstration test program. A long term power purchase agreement with the City of Tallahassee will insure the continued operation of the IGCC system. Continued operation of the IGCC plant will provide important long term plant operation and economic information to support of CPC commercialization efforts. The technology offers several advantages that improve its marketability:

- It will have been demonstrated at a commercial module size.
- It has higher thermal efficiencies than conventional pulverized coal systems.
- It offers the potential for lower capital and operating costs than competing technologies.
- It is capable of using all U.S. coals.
- It has the environmental flexibility to meet current and future environmental constraints.

CPC, through arrangements with CRS Capital, Inc., TECO Power Corporation, and the support of major energy equipment suppliers (GE and Lurgi) will be in an excellent position to exploit the commercial opportunities of the Air-Blown IGCC system.

4.0 ENVIRONMENTAL CONSIDERATIONS

The NEPA compliance procedure, cited in Section 2.2, contains three major elements: a Programmatic Environmental Impact Statement (PEIS); a pre-selection, project-specific environmental analysis; and a post-selection, site-specific environmental analysis. DOE issued the final PEIS to the public in November 1989 (DOE/EIS-0146). In the PEIS, results derived from the Regional Emissions Database and Evaluation System (REDES) were used to estimate the environmental impacts that might occur in 2010 if each technology were to reach full commercialization, capturing 100 percent of its applicable market. These impacts were compared to the no-action alternative, which assumed continued use of conventional coal technologies through 2010 with new plants using conventional flue gas desulfurization to meet New Source Performance Standards.

Next, the pre-selection, project-specific environmental review focusing on environmental issues pertinent to decision-making was completed for internal use by DOE. The review summarized the strengths and weaknesses of each proposal against the environmental evaluation criteria. It included, to the extent possible, a discussion of alternative sites and/or processes reasonably available to the offeror, practical mitigating measures, and a list of required permits. This analysis was provided for the Source Selection Official's use before the selection of proposals.

As the final element of the NEPA strategy, the Participant (CPC) submitted the environmental information specified in the PON. CPC provided this information prior to award. This detailed site- and project-specific information will be used by DOE, along with other pertinent information, to prepare an environmental impact statement (EIS) for the project. The EIS will be prepared in compliance with 40 CFR Parts 1500-1508, and must be approved before DOE can make a final decision to provide federal funds for any activity that would limit the choice of reasonable alternatives to the proposed action. The EIS for the CPC will also consider the cummulative environmental impacts which could occur if both the CPC and a CCT-1 project with the City of Tallahassee colocated at the Arvah B. Hopkins generating station are successfully completed.

In addition to the NEPA requirements outlined above, CPC must prepare and submit an Environmental Monitoring Plan (EMP) for the project. The purpose of the EMP is to ensure that sufficient technology, project, and site environmental data are collected to provide health, safety, and environmental information for use in subsequent commercial applications of the technology.

The expected performance characteristics and applicable market for the fixed-bed IGCC technology were used to estimate the environmental impacts in 2010 which would result from full commercialization of fixed-bed IGCC. The REDES model was used to compare the fixed-bed IGCC technology impacts to the no-action alternative.

From a programmatic viewpoint, Table 1 shows the projected environmental impacts from maximum commercialization of the fixed-bed IGCC technology, both

Table 1. Projected Environmental Impacts in 2010, Fixed-Bed IGCC (Percent Change over No-Action Alternative)

Region	Sulfur Dioxides	Nitrogen Oxides	Carbon Dioxide	Solid Wastes
National	-37%	-17%	-6%	-5%
Northeast	-40%	-19%	-4%	-7%
Southeast	-46%	-25%	-4%	+10%
Northwest	-7%	-6%	-3%	+34%
Southwest	-36%	-14%	-10%	-16%

Source: *Programmatic Environmental Impact Statement* (DOE/EIS-0146), November 1989.

nationally and regionally, in 2010. Negative percentages indicate decreases in emissions or wastes, while positive percentages indicate increases in emissions or wastes as compared to the no-action alternative. These results should be regarded as approximations of actual impacts.

As shown in Table 1, commercialization of the fixed-bed IGCC technology reduces both sulfur dioxide and nitrogen oxides emissions, with the largest reductions occurring in the eastern regions. The northwest quadrant would be least affected by air emissions reductions and shows an increase in solid waste production. The quadrants used in the REDES study are depicted in Figure 3.

The overall trend presented by the analysis for commercialization of the fixed-bed IGCC technology shows decreases in sulfur dioxide, nitrogen oxides emissions, and carbon dioxide emissions. Solid waste production shows a small increase in the northwest sector, but a slight decrease on a national basis.

Since the zinc ferrite bed captures most of the sulfur emissions under the high-pressure and high-temperature conditions upstream of the turbine, the need for expensive, downstream sulfur control equipment is eliminated. The sulfur dioxide removal rate is expected to be in excess of 92 percent. Reductions in nitrogen oxides below NSPS requirements are achieved through the SCR in the HRSG. The solid waste generated from the hot gas cleanup system is suitable for disposal in a landfill or can be made into a non-hazardous saleable products such as gypsum.

5.0 PROJECT MANAGEMENT

5.1 OVERVIEW OF MANAGEMENT ORGANIZATION

CRSS Capital, Inc. (CRSS), and TECO Power Services Corporation (TECO) were joint proposers for this project. Since selection, CRSS and TECO formed a new corporation, Clean Power Cogeneration, Inc. (CPC), incorporated in Delaware.

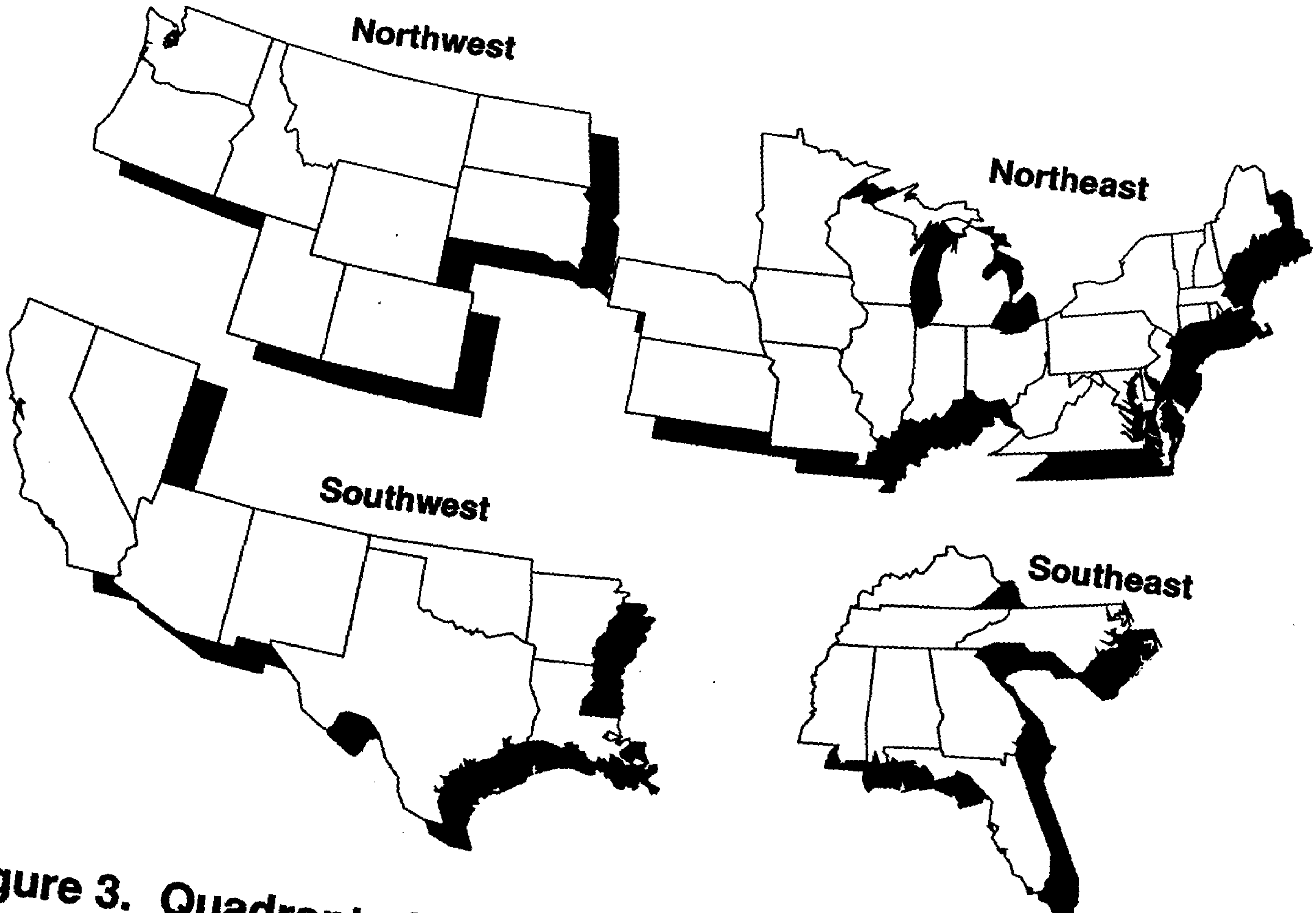

Figure 3. Quadrants for the Conterminous United States

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CRSS and TECO each own 50 percent shares in the total common stock of the project. Sequential to the formation of CPC, both CRSS and TECO formed new wholly owned subsidiaries, CRSS Power, Inc., and TPS Clean Coal, Inc., respectively. CPC, CRSS Power, Inc., and TPS Clean Coal, Inc., formed a limited partnership, Clean Power Cogeneration Limited Partnership (the Partnership) with CPC acting as the general partner. This type of organization is expected to become atypical of Independent Power Producer project organizations.

The project organization is depicted in Figure 4. As the general partner, CPC will be signatory to the Cooperative Agreement and Repayment Agreement for this project. CPC will be responsible for all aspects as regards the management of the project. CRSS and TECO, through contract to the project, will commit extensive personnel to the activities of the project for the duration of the Cooperative Agreement. As also shown in Figure 4, other key organizations which will provide contracted services to the project include CRSS Engineers, Lurgi GMBH, GE Environmental Services, Inc., City of Tallahassee, Natec, Inc.

DOE will monitor all aspects of the project, including the overall progress and direction of design, construction, start-up, and operation to ensure that all project goals are met. This monitoring will include DOE participation in critical review points.

5.2 IDENTIFICATION OF RESPECTIVE ROLES AND RESPONSIBILITIES

5.2.1 DOE

DOE will be responsible for monitoring the project and for granting or denying approvals required by the Cooperative Agreement. A DOE Project Manager will be designated by the DOE Contracting Officer. The Project Manager will be the primary point of contact for the project and will be responsible for the DOE management of the project.

5.2.2 Participant

CPC, as the Participant, will be responsible for all aspects of the project, including engineering, design, construction, start-up, operation, data collection, and reporting. CPC will utilize the services of CRS Sirrine Engineering for the engineering design and turnkey construction of the facility. Lurgi GMBH will supply two Lurgi Mark IV Gasifiers with commercial guarantees based upon tested coals. General Electric Company will supply the combined cycle power plant as well as the hot gas clean up system. CPC will appoint a Project Director who will have responsibility for oversight of the project and decision making on behalf of CPC. This Project Director will be the primary point of contact for DOE interaction.

5.3 PROJECT IMPLEMENTATION AND CONTROL PROCEDURE

CPC will prepare and maintain a Project Management Plan which presents the project procedures, controls, schedules, budgets, baseline design information, and other activities required to adequately manage the project. This document will be prepared shortly after execution of the Cooperative Agreement and will be used to implement and control project activities. Throughout the project,

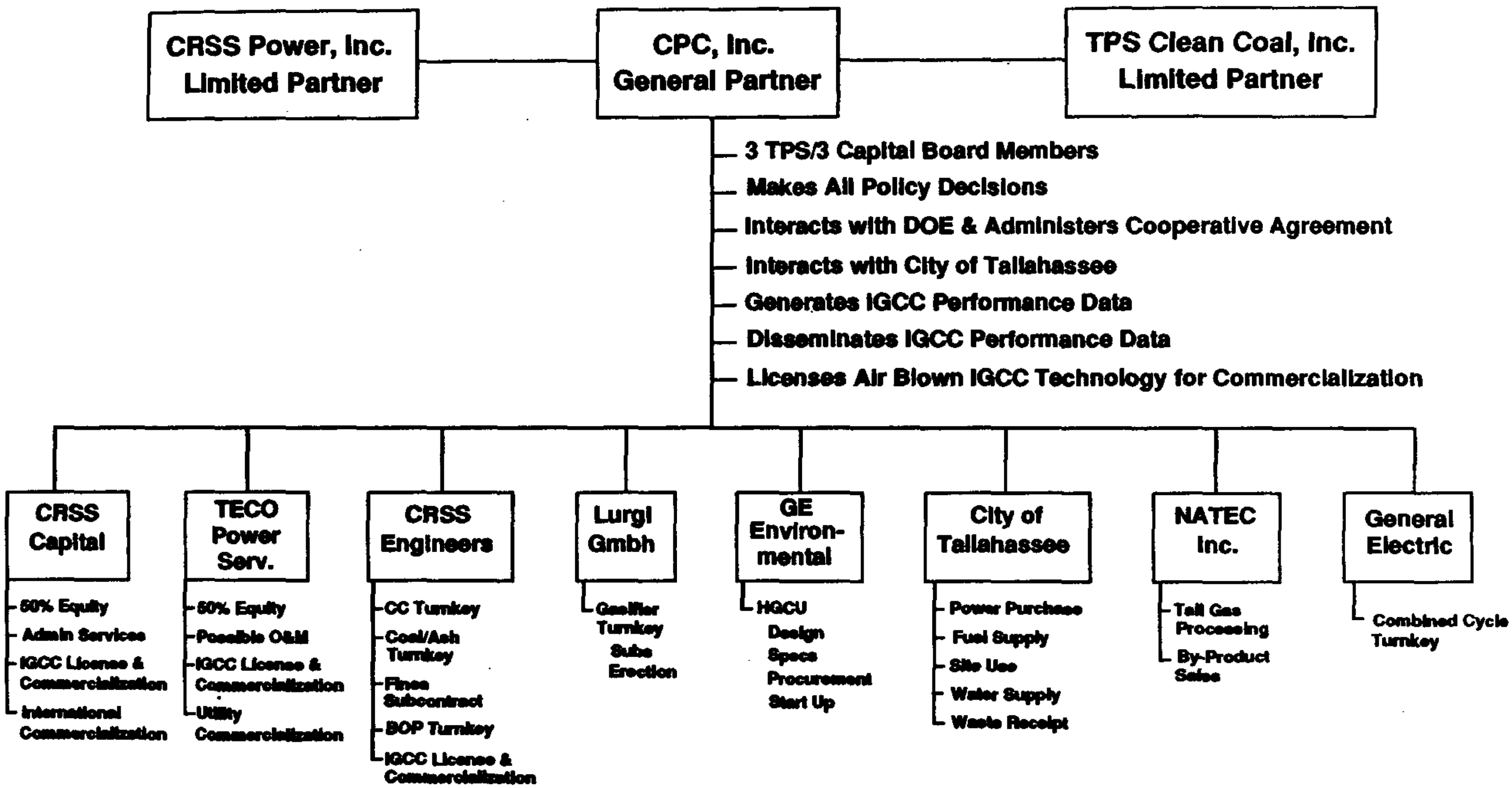

Figure 4. Clean Power Limited Partnership Management Structure

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reports dealing with the technical, management, cost, and environmental monitoring aspects of the project will be prepared and delivered to DOE.

5.4 KEY AGREEMENTS IMPACTING DATA RIGHTS, PATENT WAIVERS, AND INFORMATION REPORTING

With respect to data rights, DOE has negotiated terms and conditions which will provide for rights of access by DOE to all data generated or utilized in the course of or under the Cooperative Agreement by CPC and its subcontractors. DOE will have sufficient rights of access to nonproprietary data first produced in the performance of the Cooperative Agreement and limited rights to proprietary data utilized in the course of the demonstration. DOE will have the right to have relevant proprietary information delivered to it under suitable conditions of confidentiality. With regard to patents, data and other intellectual property, CPC, CRSS Capital and TECO have made contractual commitments that will enhance the commercialization of the air-blown, fixed-bed IGCC technology demonstrated in this project.

The Participant has requested for itself a waiver of patent rights in any subject invention i.e., any invention or discovery by any of them which is actually reduced to practice in the course of or under the Cooperative Agreement. Favorable action is anticipated to be given to the Participant's Patent Waiver request considering the level of cost sharing, the commitment by its principal sub-contractor to commercialization of the fixed-bed IGCC technology, and agreement by the Participant to repay up to the Government's contribution in accordance with the DOE guidelines. Any grant of a patent waiver will reserve to the Government a nonexclusive, nontransferable, and irrevocable paid-up license to practice or to have practiced any waived subject invention for and on behalf of the United States.

5.5 PROCEDURES FOR COMMERCIALIZATION OF TECHNOLOGY

The CPC Project will be used as a stepping stone to move the fixed-bed IGCC technology to readiness for widespread commercial application by the mid- to late-1990's. This will involve demonstration of plant reliability and performance of an integrated system at the 120-MWe scale. CPC plans to use this 120-MWe demonstration as the basis for other similar-scale and larger-scale application. Later plants are expected to be built in sizes ranging up to 240-MWe by adding modules of 120-MWe.

Throughout the U.S., particularly in the Midwest and East, there are numerous aging coal fired utility boilers without SO_2 controls which are candidates for repowering with air-blown, fixed-bed IGCC technology. Repowering of these plants with IGCC systems will result in the improved plant efficiencies, reduction of net emission rates of SO_2, NO_x and CO_2, and the addition of small increments of power resulting from the gas turbine output in the combined cycle operation. Space constraints at many generating sites further emphasize the benefits of the smaller space requirements associated with the IGCC.

As power demand grows, CPC anticipates a large potential market for new power stations utilizing air-blown, fixed-bed IGCC technology. CPC anticipates that the market for new plant construction will accelerate in the late 1990's.

6.0 PROJECT COST AND SCHEDULING

6.1 PROJECT BASELINE COSTS

The estimated cost and the cost sharing for the work to be performed under the Cooperative Agreement are as shown below. At the beginning of each budget period, DOE intends to obligate sufficient funds to pay its share of the expenses for that period.

Pre-award Cost

DOE Share	$ 900,000	50.0%
Participant Share	$ 900,000	50.0%
	$ 1,800,000	100.0%

Phase 1

DOE Share	$ 8,050,000	50.0%
Participant Share	$ 8,050,000	50.0%
	$ 16,100,000	100.0%

Phase 2

DOE Share	$ 91,679,000	50.0%
Participant Share	$ 91,679,000	50.0%
	$183,358,000	100.0%

Phase 3

DOE Share	$ 20,100,000	50.0%
Participant Share	$ 20,100,000	50.0%
	$ 40,200,000	100.0%

Total Estimated Project Cost

DOE Share	$120,729,000	50.0%
Participant Share	$120,729,000	50.0%
	$241,458,000	100.0%

6.2 MILESTONE SCHEDULE

The project is divided into three phases and is expected to take 60 months to complete. The phases and their expected durations are as shown below:

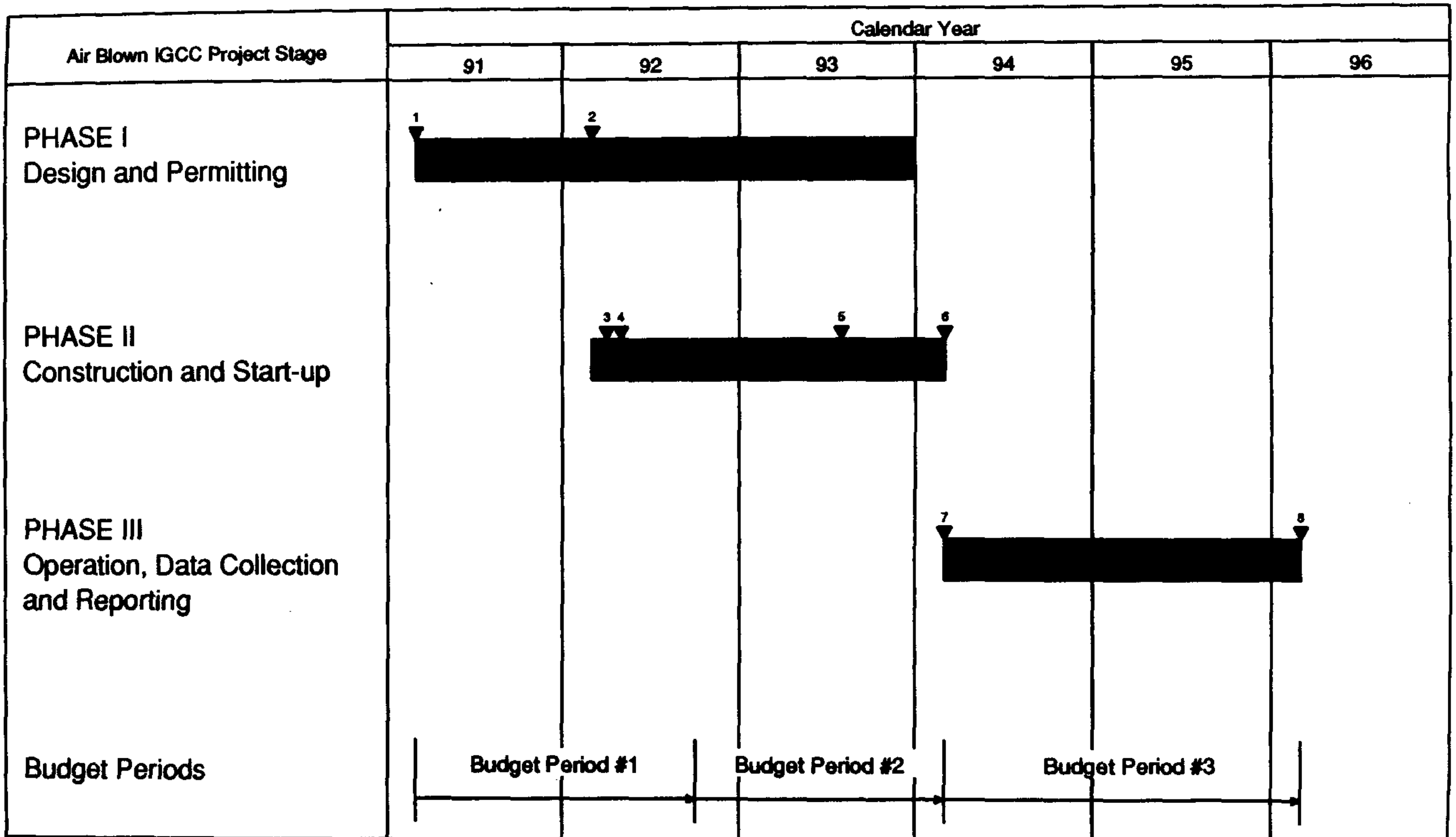
Phase 1:	Design	33 months
Phase 2:	Construction	24 months
Phase 3:	Operation	24 months

Phase 1 overlaps Phase 2 by 21 months.

A project schedule is shown in Figure 5 Construction is expected to be completed by March 1994 and the project is expected to be completed by March 1, 1996.

6.3 REPAYMENT AGREEMENT

Based on DOE's recoupment policy as stated in Section 7.4 of the PON, DOE is to recover an amount up to the Government's contribution to the project. The Participant has agreed to repay the Government in accordance with the Repayment Agreement to be executed at the time of award of the Cooperative Agreement.



Milestone	Description	Milestone	Description
1	Project Start/Engineering Release	5	Start-up Begins
2	NEPA Final Approval	6	Start-up/Construction Ends
3	Fabrication Begins	7	Demonstration Begins
4	Site Construction Begins	8	Project Complete

Figure 5. Air Blown IGCC Project Schedule

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